

PART D - DIVISION D2DETAILED SPECIFICATIONS - TECHNICAL REQUIREMENTS

1. General: This specification provides technical information required for providing both products and services associated with supply of High-Pressure (HP) turbine inner cylinder sections, overhaul of Intermediate-Pressure (IP) turbine, internal alignment of these two (2) sections, and technical direction for effectively completing all turbine Work scheduled for both the March 2002 Unit 2 and the March 2003 Unit 1 outages at the Intermountain Power Project.
2. Unit Description: IPSC consists of two (2) sister units operating S-2, triple tandem-compound, single reheat, twenty- (20-) stage, impulse-type turbines with a double-flow nozzle. The existing HP turbine is a partial arc design with seven (7) stages including one (1) fourth stage extraction, second stage rotor cooling, and first stage pressure tap. The turbine is controlled via Mark II series electro hydraulic system.

The turbines have been increased in nominal output rating from an original installation output of 840 megawatts gross to a current rating of 875 megawatts gross.

3. Scope of Work: The IPSC planned scope of Work for the turbine generator during the Unit 2 outage beginning March 2, 2002, and the Unit 1 outage beginning March 1, 2003 is:
  - a. Replacement of the HP turbine inner cylinder section.
  - b. Inspection and overhaul of the IP turbine section. *IPSC*
  - c. Testing and possible disassembly of the generator for repair of stator winding leaks. *IPSC*
  - d. Inspection and overhaul of main stop, control, combined reheat, and ventilator valves. *⇒ VALVE CADD, MARK II A CONTROL, ⇒ Full-rcn.*
  - e. Overhaul of servos, switches, and PMG at front standard. *[Signature]*

The above scope of Work is scheduled for each unit at IPSC during their respective outages.

4. Scope of Supply: This section includes the following hardware and services to be provided by ALSTOM Power:
  - a. Design, manufacture, shop testing, and delivery of a new, high-efficiency HP turbine inner cylinder section, including any required special tools. HP turbines to be designed and provided with retractable packing as indicated in Division A1, Schedule of Pricing, Page A1-1 and A1-2. The new HP turbine inner cylinder module comprises the following hardware:

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- HP inner casing shell with integral HP exhaust difusser
- Four (4) welded inlet pipe connections with piston ring seals and stellite liners (fitted into existing outer casing inkjet at site).
- Fully bladed HP rotor with eight (8) stages of advanced rotating blading with forked-pinned root fastenings and integral tip shrouds .
- Eight (8) HP fixed blade diaphragms incorporated advanced 3-D fixed blade profiles with retractable packing seals at the hubs on Stages 2-8 and extension rings supporting stationary rotating blade tip seals.
- Inlet (balance) gland casing with spring-backed <sup>N2</sup> ~~NOT RETRACTABLE~~ sealing rings and incorporating inlet flow guide.
- Two (2) <sup>AXIAL / LOCATING KEYS</sup> locating rings with packers for locating anti-rotation keys in outer casing.
- Interspace baffle ring with <sup>RADIAL FIT</sup> axial adjustment. ~~IN CASE~~
- One (1) set of replacement sleeves, including two spares, for the existing Ovako hydraulically expanded coupling bolts on the HP to IP rotor coupling <sup>JPSC</sup>
- Miscellaneous shims and packers.
- Special tooling required for new equipment (e.g., lifting equipment for fully assembled module, inner cylinder guide pillars, bolt extension measurement equipment).
- Transportation cradle for the assembled inner cylinder module.
- Operation and maintenance manuals for equipment supplied.
- Assembly drawings, interface drawings, and thermal kit revisions linked to specific equipment supplied.

The HP turbine retrofit proposal is based on the reuse of the existing HP outer casing shell and shaft end gland seals on the assumption that all of these items are in an acceptable condition. Repair or replacement of these items and other interfacing components (e.g., bearing liners, shaft end gland seals, turbovisory detectors) is not included in the scope of supply.

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Special tooling supplied under this Contract does not include for tools used in conjunction with the existing HP turbine. The existing equipment tooling (e.g., transformer kit for bolt tightening, bolt heating elements, lifting beams and slings, lifting slings for small items, wrenches for joint bolts, torque wrenches, etc.) remains available for use during the installation of the new HP turbine equipment and for future maintenance. The new cylinder half joint bolts will be designed to use the existing bolt heaters, and bolt heads are designed for standard US wrenches.

All the minor machining operations required for installation purposes are carried out by the installation contractor and are not included in the scope of supply. Replacement thermal insulation is not included in the scope of supply.

- b. Field engineering services for on-site direction during installation of the new HP turbine inner cylinder section, overhaul of the IP section, overhaul of control, stop, and combined reheat valves, overhaul of front standard servos, and instrumentation testing, and operation of the completed turbine as listed in Section 6.

Field engineering services for on-site direction during the overhaul of the IP section, overhaul of control, stop, and combined reheat valves, overhaul of front standard servos and instrumentation testing, and operation of the completed turbine as listed in Section 6. Subject to agreement between ALSTOM and IPSC regarding manpower and any additional charges. ✓

- c. Field direction of electro hydraulic control system modifications for optimized valve operation including parts as required for the modification.

- d. Internal alignment services for the IP turbines. *F\$45,000*

*TALKED TO BILL.  
He SUGGESTED ABOUT  
AFTER 111 ONTARIO.*

- e. On-site training for complete HP-IP overhaul/retrofit. Training agenda to be prepared based on a one (1) week, forty- (40-) hour schedule. Training to cover all aspects of overhaul including alignment for approximately thirty (30) people.
- f. Any reverse or interface system engineering required for successful design and installation of the retrofit HP turbine.

5. Design Conditions and Criteria: The justification for this project rests on both performance and output. Therefore, all reasonable effort shall be made to identify and incorporate the most current and proven performance related technologies.

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IPSC understands that by design, the new, high-efficiency HP turbine sections are unable to provide both partial-arc and full-arc operational modes. Accordingly, IPSC chooses to specify a full-arc operational design to take advantage of upper end operating efficiencies.

As a part of the modification to exclusive, full-arc control, ALSTOM shall provide required hardware and technical support for modifying existing valve operation. ALSTOM shall ensure that valve control, unit stability, and generation flexibility are not restricted, encumbered, or complicated beyond current capabilities.

The HP section shall be designed for the following throttle conditions and flow passing capability at VWO:

- a. 2400 psi.
- b. 1000° F.
- c. 6,900,000 lbs/hr.
- d. Three (3) percent pressure drop: HP valve inlet to HP turbine inlet.

The 1997 IFC Steam Tables shall be the exclusive reference used for calculation of HP section efficiency. The guaranteed HP turbine efficiency shall be 92.2 percent including valves.

All the HP turbine retrofit components will be made from materials procured to ALSTOM Power Purchase specifications which have been developed specifically for application on large steam turbines. In general, the materials of the major components will have compositions and mechanical properties which correspond closely to the approximate equivalent AISI/ASTM materials. Comparisons of ALSTOM Power material specifications and equivalent AISI/ASTM material specifications will be provided under the Contract.

The HP section steam path components shall be designed with a plasma-nitride, erosion-resistant treatment package. Specific type and application location information shall be provided to IPSC with Contract documentation.

ALSTOM shall be solely responsible for ensuring that all piping penetrations, instrument taps/wells, interfacing keys and supports, journals, couplings, snout sections, seals, etc., are properly located and sized.

Maximum allowable vibration in any plane in the fully assembled and operating turbine shall be in accordance with ISO 7919-2 Zone A requirements for 3600 RPM equipment.

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The HP turbine sections provided for installation on Unit 1 and Unit 2 shall be operationally interchangeable in every regard.

6. Field Service Engineering: The Field Service Engineer shall arrive on site no later than two (2) weeks prior to the respective outage scheduled start dates. The Field Service Engineer shall be available in accordance with the planned outage shift schedule, from two (2) weeks prior to the outage scheduled start date, until released by IPSC following successful startup and operation of the turbine. The construction supervisors shall arrive at the site no later than three (3) days prior to the start of the outage.

As part of this Contract, ALSTOM shall also provide general engineering advice and revised cycle data to allow assessment of the impact of the HP turbine retrofit on interfacing cycle components by IPSC at the new rated operating conditions. These engineering evaluations shall include boiler input/output requirements, IP and LP turbine impacts, as well as generator cooling requirements. ALSTOM shall make specific engineering evaluations of the following systems to ensure reliable operation of the new HP turbine section:

- a. Gland steam sealing system.
- b. Turbine drain system.
- c. Lubricating oil system.
- d. Governor and control system.
- e. Instrumentation and protection systems.

A minimum of two (2) qualified construction supervisors shall be provided, one (1) for the day shift and one (1) for the night shift. One (1) Field Service Engineer shall also be provided for technical direction throughout the outage. These three (3) individuals, together, shall perform the following functions:

- a. Technical direction to IPSC for disassembly, cleaning, inspection, repair, part replacement, reassembly, rotor alignment, balancing, etc., of the steam turbine-generator components and section identified within Section 3, Scope of Work.
- b. Assist IPSC with overhaul planning, schedule preparation, and schedule updating.
- c. Prepare and submit to IPSC a technical report which details the inspections, repairs, and future recommendations related to the Work done on the turbine.

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The field service personnel shall have had formal training for field construction and technical support on large, impulse design, steam turbines. These individuals shall have at least ten (10) years of field construction or engineering experience in their respective job functions in installation, repair, and operation of these type machines.

At least six (6) weeks prior to the outage, the Field Service Engineer and one (1) construction supervisor shall come to the site and participate in a finalization planning meeting for the Retrofit Outage.

7. Internal Alignment Services: ALSTOM shall provide labor, supervision, expertise, tools, and equipment for full internal alignment of the IP section of the turbine. Where laser alignment technology is employed, ALSTOM or its subcontractor shall test all equipment at ALSTOM or its subcontractor's shop prior to mobilizing to the site to prevent downtime due to faulty equipment.

ALSTOM shall provide adequate numbers of trained personnel in order to judiciously pursue completion of the internal alignment, without interruption, within the scheduled alignment window.

ALSTOM/subcontractor alignment personnel shall be responsible for obtaining alignment data, advising IPSC personnel as to required moves, and assuring that IPSC personnel have achieved the moves as requested. The physical work of adjustments will be carried out by IPSC staff, not by ALSTOM/Laser alignment personnel.

Alignment personnel must be able to effectively coordinate all alignment information with the applicable turbine supervisors, repair/supporting contractors, and assigned engineers at the site, regardless of corporate affiliation.

Personnel conducting turbine internal alignment Work shall be trained and qualified in the procedures used and in operation of the equipment required for the Work. The personnel shall have performed the same Work on at least ten (10) previous occasions, and at least five (5) of those on large, impulse design steam turbines.

8. IPSC Provided Facilities: IPSC will provide two (2) desks in an enclosed office trailer on the turbine deck for the Field Service Engineer to use. The trailer will also be occupied by IPSC personnel.

IPSC will provide a single telephone line in the office trailer for use by the Field Service Engineer.

IPSC will provide access to a fax and copy machine for use by the Field Service Engineer.

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9. Reference Drawings: These drawings are provided as references on which the initial ALSTOM offering and guarantees were based.

- Figure 1 - Unit 1, Benchmark Test Heat Balance.
- Figure 2 - Unit 2, Benchmark Test Heat Balance.
- Figure 3 - Unit 1, Operating Heat Balance.
- Figure 4 - Unit 2, Operating Heat Balance.

The final ALSTOM guarantees are based on Figure 5 (Unit 1) and Figure 6 (Unit 2), which also show the definition of HP efficiency and give the HP wheel section power for information.

10. Operating Experience: For ALSTOM's information only, IPSC has operated for the past five (5) to six (6) years with net capacity and availability factors in excess of 90 percent, with net output in excess of 95 percent.

Weekly valve and yearly tightness and over speed testing have been successfully completed since original installation.

Turbine startups have been relatively smooth on both units. Only rarely is a balance shot required during startup.

A Load Profile (Figure 5), typical of recent years is enclosed for your information.

11. Maintenance History and Provisions: The IPSC turbines were overhauled completely by the OEM approximately two (2) years after start of commercial operation. Since that time, all maintenance on the turbines has been performed by IPSC personnel under the direction of a Field Service Engineer.

Turbine oil is monitored by on-site predictive maintenance personnel who are fully trained in ferrographic, particulate, and inductively coupling plasma analysis. The turbine oil was recently replaced on both units as the oil additive packages were showing signs of degradation affecting the oil/moisture separation properties; however, moisture has remained continually within allowable limits.

IPSC is aware of no dimensions affecting the installation of a new HP that have been modified since installation. The only significant modifications to the turbine since startup are as follows:

- a. Hydraulic Coupling Bolts, Ovako, Inc.
- b. Retractable Packing, Turbocare, Inc.

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12. Manufacturing Schedule: Within six (6) weeks of Contract award, ALSTOM shall submit a detailed schedule showing all facets of completion for the HP turbine section and associated components. The schedule shall include:

- a. Order placement for material stock for each major component.
- b. Expected delivery to manufacturing facilities of stock for each major component.
- ✓ c. Start of material acceptance testing for each major component.
- ✓ d. Start of manufacture of each major component.
- e. Start of shop testing for each major component.
- f. Start of component subassembly (i.e., rotor assembly, diaphragm assembly, etc.)
- g. Start of subassembly testing (i.e., rotor testing, diaphragm NDE, and final dimensions).
- h. Start of assembly (alignment, etc.).
- i. Final assembly dimensional verification.

Updated manufacturing progress reports shall be prepared and submitted to IPSC on a monthly basis starting the first month after Contract award and continuing up to the date of final inspection and shipment. ALSTOM shall give IPSC thirty (30) days advance notice of testing designated with an "N" on the Summary of Quality Control Actions table (enclosed).

13. Drawings to be Supplied Under this Contract Comprise:

- a. Interface drawings.
- b. Modifications to existing components at interfaces.
- c. Assembly drawings.
- d. Rotor clearance drawings.
- e. Diaphragm alignment drawings.
- f. Lifting drawings.
- g. "As-made" modifications to any of the above drawings.

14. HP Section Performance Testing: Initial HP section efficiency/HP wheel power output or HP swallowing capacity testing shall occur as soon after the outage as reasonably possible. The initial guarantee performance verification test for HP section efficiency and HP swallowing capacity will be carried out as soon as practicable after the unit is



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restarted following the retrofit installation. IPSC anticipates the ability to complete the initial testing within one (1) to two (2) weeks of startup; however, several factors could develop that could delay the test. These factors include an inability to achieve stable or acceptable turbine vibration limits, lack of permission from dispatch authority, unforeseen load demands, or problems with other plant equipment. In addition to initial performance testing, IPSC will complete an identical confirmation test approximately thirty (30) days following initial performance testing. Performance incentives/penalties shall be calculated and awarded based on the average of the initial performance test results and the thirty- (30-) day confirmation test results, both completed within a maximum of eight (8) weeks of restarting the units.

In order to monitor any abnormal efficiency deterioration, benchmark enthalpy-drop tests will be taken periodically from the time of initial loading of the turbine and the results recorded for reference purposes. If any excessive deterioration is observed (over and above that which would be expected from reference to the ASME PTC 6 Report 1985 Report - see below) a testing allowance equal to the difference between the measured deterioration and the ASME guidance norm will be applied. Similarly, if the tests are delayed beyond the recommended eight (8) weeks after resynchronization, an agreed deterioration allowance will be applied to the results.

Guidance on test delay given in the ASME PTC 6 Report 1985 Report (Section 3.06 - Timing of Tests - Fig. 3.3) is based on industry experience representing average expected deterioration for units with a history of good operating procedures and water chemistry. The guidance given for heat rate deterioration is built up from enthalpy-drop tests on a number of turbines. For turbine configurations of the same type as Intermountain, the HP turbine may be taken to account for approximately 50 percent of the total degradation.

ALSTOM is invited to be present during all testing. IPSC will apply best effort to confer with ALSTOM regarding all issues that may affect the evaluated performance of the turbine.

IPSC will prepare a specification and engage a qualified contractor for the performance tests. For general information, the following criteria will form the basis of the performance testing:

- a. The unit shall be operated at steady state, full load for approximately one (1) hour prior to start of test.
- b. Steady state shall be defined as fluctuations of not greater than:
  - (1) 0.25 percent of absolute pressure readings.
  - (2) 7.0° F temperature readings.

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- c. Test shall consist of a minimum sixty- (60-) minute test, with readings taken a minimum of every two (2) minutes.

All readings shall be taken from at least two (2) parallel points allowing for direct indication of faulty equipment. Both elements shall be monitored and recorded during the equalization period and throughout the performance test for increased accuracy.

All testing instrumentation shall be calibrated and traceable to the National Bureau of Standards. Instrumentation shall be calibrated both before and after testing is complete.

The cost of one (1) initial HP section efficiency/HP section wheel power output test or HP swallowing capacity test following the outage and one (1) identical confirmation test approximately thirty (30) days subsequent, will be borne by IPSC. All testing shall be considered valid and contractually binding if the HP section efficiency or the HP section wheel power output is tested to be no more than 2.0 percentage points below guaranteed efficiency.

Should excessive performance degradation between the initial performance test and the confirmation test occur, guidelines from ASME PTC 6 1985 Report shall be applied.

If the measured section efficiency during either the initial HP section efficiency/HP section wheel power output test or the identical thirty (30) day confirmation test is more than 2.0 percentage points below guaranteed, an additional test shall be run and paid for by IPSC, as soon after the first test as operationally reasonable.

If the initial and confirmatory tests are within the 2.0 percent window, the testing results shall be considered valid and contractually binding. If an additional second test is necessary and the additional second test is outside (below) the 2.0 percent window, testing results from all of the first and second performance tests shall be averaged to produce the valid and contractually binding HP section performance.

HP section efficiency shall be defined as measured across both the valves and the HP section from throttle conditions to the HP section exhaust.

Prior to assessing penalties or incentives, HP section power output efficiency and HP swallowing capacity shall be corrected for variations in specified terminal conditions using correction factors agreed in advance of the tests.

15. Contract Document Submittals: During the course of fabrication of the HP section, ALSTOM shall submit the following information in accordance with the monthly updated manufacturing schedules and reports outlined in Section 12 of this Division. As-built or updated revisions shall be prepared and submitted following installation of each respective HP inner cylinder section.

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- a. A revised thermal kit based on the specific throttle conditions.
  - b. Ongoing Q/A reports as specified in the Summary of Quality Control Actions Table as referred to in Division D2, Section 12.
  - c. Mill certificates.
  - d. Manufacturing progress reports.
  - e. Rotor balance report including static unbalance at critical speeds and rated speed.
  - f. Rotor run-out report.
  - g. Calculated rotor torsional characteristics (sufficient to demonstrate that the new HP rotor has negligible impact on the shaft line torsional characteristics).
  - h. Assembly and interface drawings.
  - i. Component and assembly rigging plan including accurate weight of each lift.
  - j. Piping connection and instrumentation port location drawings.
  - k. Within thirty (30) days after award of Contract, ALSTOM shall submit a schedule of submittals including all drawings by title and their estimated submittal and approval return dates.
  - l. Itemized list of each major component showing design weight.
  - m. Steam seal clearance diagrams.
  - n. Steam path dimensions and tolerances for eventual repair of internal components.
16. Existing HP Section Availability: The existing Unit 1 HP turbine at IPSC is currently scheduled to be available for inspection, measurement, and condition assessment during the upcoming outage beginning March 5, 2001. During this outage, the following items on the turbine will be disassembled for inspection:
- a. Top half outer casing removed.
  - b. Top half N1 gland casing removed.

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- c. First and second pedestals opened and bearing top halves removed.
- d. One (1) gland ring removed from N1 and N2 at each diameter for Pi tape measurements.

ALSTOM shall have up to four (4) days of access for inspection of the HP turbine on Unit 1. **The HP turbine inner casing will not be open. The extraction lines will not be severed or unbolted.**

17. Shipping: All components and assemblies shall be packaged, coated, supported, and secured to prevent corrosion, damage, or deformation during shipping. Any damage sustained prior to delivery to the IPSC facility shall be judiciously corrected by and to the account of ALSTOM.

Bearing journals areas shall be securely covered and protected by treated cotton cloth or acceptable equal to prevent inadvertent contact or corrosive elements.

18. Maintenance Manuals: ALSTOM shall provide ten (10) sets of maintenance manuals at time of delivery, including the following information applicable to ALSTOM's scope of supply:

- a. Detailed overhaul recommendations.
- b. General arrangement drawings.
- c. Rotor clearance drawings.
- d. Diaphragm alignment drawings.
- e. Longitudinal X-section elevation.
- f. Shaft torque characteristic plot.

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